Small Municipal Separate Storm Sewer System (MS4) General Permit "Lake Phosphorus Control Plan (LPCP)" for Newton Pond
Legal Analysis

TO: Town of Boylston

FROM: Jennie Moonan, PE, Project Manager and Cassandra LaRochelle, PE, Project Engineer

DATE: September 28, 2020

Tighe & Bond is providing this memorandum to the Town of Boylston to document requirements of the U.S. Environmental Protection Agency's (EPA's) *General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems* (MS4GP) related to discharges to Newton Pond and its tributaries (see Part 2.2 and Appendix F of the MS4GP).

Overview of Newton Pond's Water Quality Concerns

As you are aware, a portion of the Town of Boylston's MS4 discharges to Newton Pond. Newton Pond occupies approximately 54 acres in both Boylston and Shrewsbury. In Boylston, the pond is located south of Mill Street, east of Main Street, and west of Sewall Street. The pond is fed by Sewall Brook. The watershed of Newton Pond is approximately 4.29 square miles. Figure 1, below, shows the location of Newton Pond and the approximate watershed using the Massachusetts Watershed Based Plan toolkit, available online at:
http://prj.geosyntec.com/MassDEPWBP/PlanWizard/SelectWatershed

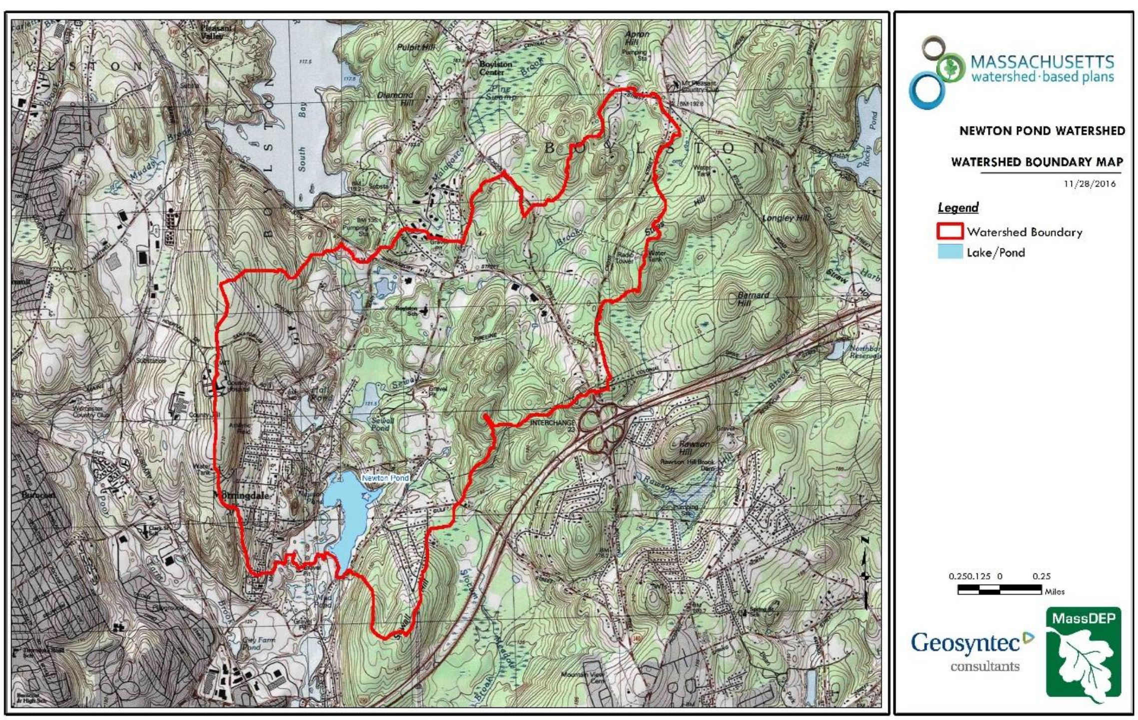

FIGURE 1: Newton Pond Watershed

An export of the Watershed-Based Plan for Newton Pond is enclosed, which provides additional background information about the watershed and water quality concerns.

A Total Maximum Daily Load (TMDL) (a.k.a. "pollution budget") for phosphorus was developed and approved in April 2002 for select waterbodies (lakes and ponds) in the Northern Blackstone River watershed, including Newton Pond[1].

Phosphorus is a nutrient that, when present at high levels in natural waterbodies, can cause overgrowth of aquatic plants, increased harmful algal blooms, decreased light in a waterbody, and decreased levels of dissolved oxygen, thereby impairing designated uses (aquatic life, fish consumption, primary and secondary contact, and aesthetics) per the Commonwealth's Surface Water Quality Standards (314 CMR 4.00). Phosphorus is a common pollutant in stormwater, with sources including leaf litter, pet waste, road salt, fertilizer, and atmospheric deposition. A variety of structural (infiltration and treatment structures) and non-structural (such as street sweeping and catch basin cleaning) Best Management Practices (BMPs) can be effective at reducing phosphorus loads from stormwater.

There was limited data collected by the Massachusetts Department of Environmental Protection (MassDEP) in July 1994 that informed the TMDL and there was no detailed study of the nutrient sources within the watersheds conducted to develop the TMDL. Thus, nutrient sources were estimated based on land use modeling within MassDEP's NPSLAKE model.

Since approval of the TMDL in early 2002, iterations of the Integrated List of Waters has consistently listed Newton Pond as being impaired by aquatic plants (non-native) and by noxious aquatic plants (macrophytes). The latter impairment is covered by the TMDL. However, in the Massachusetts Final 2016 Integrated List of Waters, approved in January 2020, the aquatic plant (macrophytes) impairment was *removed* for Newton Pond because, as stated in the List, "applicable water quality standards [are] attained; according to new assessment method." Excerpts from the 2014 and 2016 Integrated List of Waters are enclosed.

However, correspondence with permit writers at EPA indicates that an update to the Integrated List of Waters list does not supersede a TMDL and a state can only change a TMDL by updating or withdrawing it. Each community remains subject to that TMDL and the MS4GP permit conditions until the applicable TMDL is updated by the State. EPA recommended coordination with MassDEP.

EPA's Lake (and Pond) Phosphorus Reduction Requirements

To address a required phosphorus reduction of 19% in Newton Pond, the MS4GP requires Boylston to develop a written Lake Phosphorus Control Plan (LPCP) and fully implement all control measures as soon as possible but no later than June 30, 2033 (15 years from effective date of MS4GP). The LPCP includes the following elements:

By June 30, 2020:	Legal analysis
By June 30, 2021:	Funding source assessment
By June 30, 2022:	Define LPCP scope/area and calculate baseline phosphorus, allowable phosphorus load, and phosphorus reduction requirement
By June 30, 2023:	Describe planned nonstructural and structural controls, operation & maintenance (O&M) program, implementation schedule, costs, funding sources assessment (update), and prepare a fully written LPCP

[1] Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes (TMDL Report Number: MA51004-2002-3), https://www.mass.gov/doc/final-tmdl-for-northern-blackstone-lakes/download

The MS4GP assumes phosphorus will first be addressed with non-structural controls (street sweeping, catch basin cleaning, and enhanced leaf litter pickup), assessing performance of those controls, and then adding structural controls and assessing performance over the remaining years through 2033.

Given the recent change in impaired waterbody status that de-lists the segment for the impairment covered by the TMDL, advice from EPA, and the hefty planning, capital, operational, and administrative costs associating with preparing and undertaking the LPCP, we recommend the Town of Boylston engage Town Counsel to prepare a persuasive letter to MassDEP to request an update to the TMDL. The Town may wish to coordinate this effort with Shrewsbury's Town Manager and legal counsel.

LPCP "Legal Analysis" Requirements

Because, according to EPA, the permit requirements still apply to the Town of Boylston despite the delisting of the impairment covered by a TMDL, we are providing this memorandum to document compliance with Part 2.2 and Appendix F.

According to Appendix F, as part of developing and implementing a LPCP designed to reduce the amount of phosphorus in stormwater discharges from the MS4 to Newton Pond and its tributaries, Boylston must conduct an analysis of local legal authority that may be necessary to effectively implement the entire LPCP (termed by EPA as a "legal analysis"). A description of the Phase 1 PCP Legal Analysis, as stated in the MS4GP, reads as follows:

> *The permittee shall develop and implement an analysis that identifies existing regulatory mechanisms available to the MS4 such as by-laws and ordinances and describes any changes to these regulatory mechanisms that may be necessary to effectively implement the LPCP. This may include the creation or amendment of financial and regulatory authorities. The permittee shall adopt necessary regulatory changes by the end of the permit term.*

Tighe & Bond has prepared the LPCP Legal Analysis to identify existing regulatory mechanisms available to the Town such as bylaws and regulations and any changes to regulatory mechanisms that may be necessary to effectively implement the entire LPCP. The following includes an analysis of available non-structural, structural, and semi-structural phosphorus reduction actions; current legal authority of the Town to implement those actions on both public and private property; and future changes that would be required to fully implement the LPCP. This analysis also considers the potential use of a Stormwater Utility or Enterprise Fund that could include a credit system for private properties, as well as the potential for EPA taking Residual Designation Authority (RDA) over private properties.

Legal Authority to Implement the LPCP on Public Property

Current Authority

The Town of Boylston has authority to undertake all structural and non-structural controls on public property. Public property consists of Town owned or operated parcels including parking lots, as well as municipal roadways and the right of way. Boylston can complete street sweeping, catch basin cleaning, and although perhaps not desired, an enhanced Organic Waste and Leaf Litter Collection program, both now and in the future. Boylston has authority to install structural or semi-structural BMPs on Town-owned lands.

Changes Needed

There are no legal changes necessary to implement the LPCP on public property. However, requiring all public new and redevelopment projects to implement structural BMPs, beyond those required by current local code, requires buy-in from municipal officials and planning for these efforts in capital and operational budgets.

Legal Authority to Implement the LPCP on Private Property

Current Authority

Considerations are organized by type of BMP.

- Enhanced sweeping: Boylston has no authority to physically sweep on private individual properties.

- Catch Basin Cleaning: Catch basin cleaning on private properties by a private entity can only be enforced under a local permit or Order of Conditions that requires catch basin cleaning through an O&M plan currently required for under jurisdiction of Wetlands, Stormwater, and/or Site Plan Review.

- Organic Waste and Leaf Litter Collection program: Boylston has no authority to require this work on private property; further, the Town has no control over the method of disposal on private individual properties. While Boylston does hold yard waste collection days each Fall, in order to meet the Organic Waste and Leaf Litter Collection program requirements in Appendix F, the Town must gather and remove all landscaping wastes, organic debris, and leaf litter from impervious roadways and parking lots at least once per week during the period of September 1 to December 1 of each year.

- Structural BMPs[2]: Structural BMPs on private properties can only be required through issuance of a local permit or Order of Conditions that requires structural BMPs as part of permit conditions and/or O&M plan currently required for projects under jurisdiction of Wetlands, Stormwater, and/or Site Plan Review. **Currently, it is impossible under local code for the Town to require a completed project to retrofit the drainage system to add structural BMPs.**

- Semi-Structural BMPs[3]: There is limited opportunity to require semi-structural BMPs through current code.

Changes Needed

To fully implement the LPCP on private property, there would need to be significant changes to local and/or state and federal permitting. Note that the Newton Pond watershed area covers only a portion of Boylston, as shown in Figure 1. Additionally, the Town's MS4 covers only a portion of the Newton Pond watershed. The requirements of the LPCP are only applicable in the area covered by both the watershed and the MS4.

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[2] Structural BMPs include infiltration trench, infiltration basin or other surface infiltration practice, bio-filtration practice, gravel wetland system, porous pavement, wet pond or wet detention basin, dry pond or detention basin, dry water quality swale/grass swale

[3] Semi-structural BMPs include impervious area disconnection through storage (e.g., rain barrels, cisterns, etc.), impervious area disconnection, conversion of impervious area to permeable pervious area, and soil amendments to enhance permeability of pervious areas

Some changes to consider include:

1. Potentially reducing the threshold by which a project would be reviewed locally and obtain a stormwater management permit. Currently the Town threshold is one acre.[4] Reducing this threshold would require new and redevelopment projects to comply with phosphorus reduction requirements.

2. Changes to roadway width, parking, and other requirements in zoning and subdivision that result in creation of impervious cover.

3. Development of a rain barrel program.

4. Developing a Stormwater Utility or Enterprise Fund and incentivizing private sites to take their own actions through a credit system.

5. Politically, it will be very challenging if not impossible to require private properties to retrofit a site without some construction otherwise ongoing. EPA Region 1 has been petitioned to take Residual Designation Authority (RDA)[5] of various watersheds. Boylston can consider supporting a RDA petition, if desired, however, elected officials and decision makers should carefully consider balancing Town needs with the economics of private landowners.

Enclosures

Initial Watershed-Based Plan - Newton Pond

Excerpts from Massachusetts Year 2014 Integrated List of Waters

Excerpts from Massachusetts Year 2016 Integrated List of Waters

[4] The Town's Stormwater Control By-law is Article VI, Section 9 of the General By-laws. The Boylston Conservation Commission Rules and Regulations for Stormwater include additional stormwater control requirements.

[5] EPA and the authorized states regulate stormwater discharges from regulated MS4s, industrial activities, and construction sites under section 402(p) of the Clean Water Act. These stormwater discharges require NPDES permits. In addition, EPA can use its "residual designation" authority under 40 CFR 122.26(a)(9)(i)(C) and (D) to require NPDES permits for other stormwater discharges or category of discharges on a case-by-case basis when it determines that:

- the discharges contribute to a violation of water quality standards,
- the discharges are a significant contributor of pollutant to federally protected surface waters, or
- controls are needed for the discharge based on wasteload allocations that are part of TMDLs that address the pollutant(s) of concern.

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WATERSHED-BASED PLAN

Newton Pond

Initial Draft - September 2020

Prepared By:

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Prepared For:

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Commonwealth of Massachusetts
Department of Environmental Protection

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Elements F & G: Implementation Schedule and Interim Measurable Milestones

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Element A: Identify Causes of Impairment & Pollution Sources

Element A: Identify the causes and sources or groups of similar sources that need to be controlled to achieve the necessary pollutant load reductions estimated in the watershed based plan (WBP).

1. General Watershed Information

Table A-1: General Watershed Information

Watershed Name (Assessment Unit ID):	Newton Pond (MA51110)
Major Basin:	BLACKSTONE
Watershed Area (within MA):	2749.6 (ac)
Water Body Size:	54 (ac)

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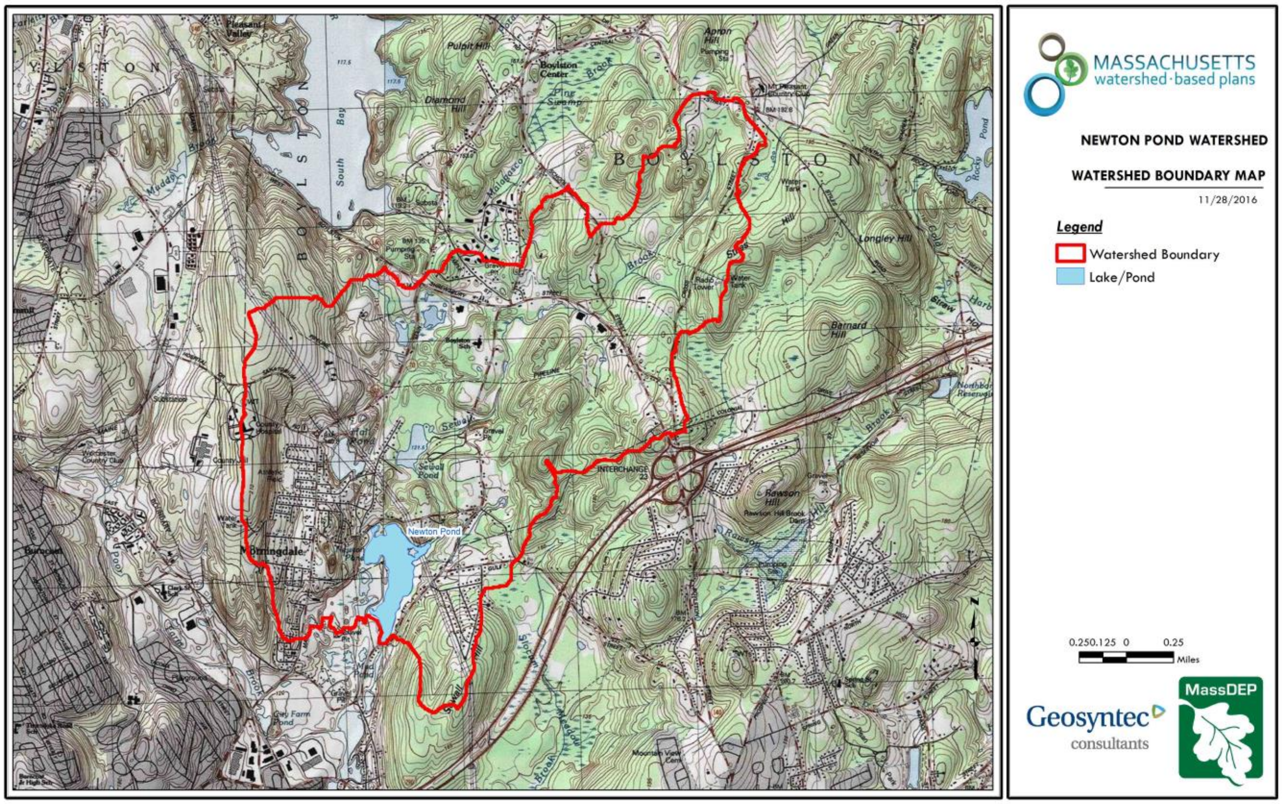

Figure A-1: Watershed Boundary Map (MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Ctrl + Click on the map to view a full sized image in your web browser.

General watershed information:

2. MassDEP Water Quality Assessment Report and TMDL Review

The following reports are available:

- Blackstone River Watershed 2003-2007 Water Quality Assessment Report
- Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes

Blackstone River Watershed 2003-2007 Water Quality Assessment Report (MA51110 - Newton Pond)
Aquatic Life Use Biology Two non-native aquatic macrophyte species (Myriophyllum heterophyllum and Cabomba caroliniana) were observed in Newton

Pond during the 1998 synoptic surveys (MassDEP 1998).

The Aquatic Life Use is assessed as impaired for Newton Pond because of the infestation with M. heterophyllum and C. caroliniana, non-native aquatic macrophytes.

Report Recommendations:
Continue to monitor for the presence of invasive non-native aquatic vegetation and determine the extent of the infestation. Prevent spreading of invasive aquatic plants. Once the extent of the problem is determined and control practices are exercised, vigilant monitoring needs to be practiced to guard against infestations in unaffected areas, including downstream from the site, and to ensure that managed areas stay in check. A key portion of the prevention program should be posting of boat access points with signs to educate and alert lake-users to the problem and their responsibility to prevent spreading these species. The watershed/canoe/kayak groups should consider seeking volunteers to provide outreach on preventing the spread of exotic invasive plants at popular access points during the busiest weekends of the summer. The Final GEIR for Eutrophication and Aquatic Plant Management in Massachusetts (Mattson et al. 2004) should also be consulted prior to the development of any lake management plan to control non-native aquatic plant species. Plant control options can be selected from several techniques (e.g., bottom barriers, drawdown, herbicides, etc.) each of which has advantages and disadvantages that need to be addressed for the specific site. However, methods that result in fragmentation (such as cutting or raking) should not be used for many species because of the propensity for these invasive species to reproduce and spread vegetatively (from cuttings).

Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes (MA51110 - Newton Pond)

Waterbody Descriptions and Problem Assessment
Landuse information for each watershed is based on MassGIS digital maps derived from aerial photography taken in 1985. To account for changes in landuse, population growth rates are reported for towns closest to the lake. Population (census) data and estimated growth rates are from projections provided on the internet (www.umass.edu/miser/) by the Massachusetts Institute for Social and Economic Research (MISER) at the University of Massachusetts, Amherst.
Lake Description
Newton Pond Shrewsbury is approximately 48 acres in size. The watershed is 61 percent forested and about 22 percent is in rural landuse category. About 12 percent is in urban landuse and both water and wetlands accounting for the remaining 5 percent. A large gravel pit is located just to the southwest shore of the lake that may contribute sediments and nutrients to the lake. Population in the town has been described above. The pond was assessed by DEP in the summer of 1994 and the assessment comments reported: "A 22 July 1994 synoptic survey indicates that floating leaf plants of 75% to 100% density were found in patches around shores and in coves (approximately 25% of the north part of the lake). There were no floating leaf plants at the end of the lake off Sewall street at the outlet and there were moderate submerged. The possible non-native Myriophyllum (possibly heterophyllum) was present
and threatens the secondary contact over 43 acres of the pond. No other data was available to make assessments."
Pollutant Sources and Background:
Unfortunately, no detailed study of the nutrient sources within the watersheds has been conducted to date. Thus, nutrient sources were estimated based on land use modeling within the DEP's NPSLAKE model as discussed below. The NPSLAKE model was designed to estimate watershed loading rates of phosphorus to lakes. A brief description of the NPSLAKE model and data inputs is given here. MassGIS digital maps of land use within the watershed were used to calculate areas of landuse within three major types: Forest, rural and urban landuse. This model takes the area in hectares of land use within each of three categories and applies an export coefficient to each to predict the annual external loading of phosphorus to the lake from the watershed. Because much of the landuse data is based on old (1985) aerial photographs, the current landuses within the watershed may be different today. This can be important in the development of the TMDL because different landuses can result in different phosphorus loadings to the waterbody in question. For many rural areas, landuse changes often result in conversion of open or agricultural lands to low density housing, in which case, the export coefficients of the NPSLAKE model are the same and no change in loading is predicted to occur. However, in cases where development changes forests to residential areas or rural landuses to urban landuses, phosphorus loadings are predicted to increase. In some cases, loadings are predicted to decrease if additional agricultural land is abandoned and forest regrowth occurs. To account for this uncertainty in landuse changes, a conservative target is chosen (see below). In addition, the MassGIS landuse maps are scheduled to be updated with current aerial photos and the TMDL can be modified as additional information is obtained.

Other phosphorus sources, such as septic system inputs of phosphorus, are estimated from an export coefficient multiplied by the number of homes within 100 meters of the lake. Point sources are estimated manually based on discharge information and site specific information for uptake and storage. Other sources such as atmospheric deposition to lakes was determined to be small and not significant in the NPSLAKE model, perhaps because lakes tend to be sinks rather than sources of phosphorus (Mattson and Isaac, 1999). For similar reasons wetlands were also not considered to be significant sources of phosphorus following (see discussion and references in Mattson and Isaac, 1999). Other, non-landuse sources of phosphorus such as inputs from waterfowl were not included, but can be added as additional information becomes available. If large numbers of waterfowl are using the lake the total phosphorus budget may be an underestimate, and control measures should be considered. Internal sources (recycling) of phosphorus is not included because it is not considered as a net external load to the lake, but rather a seasonal recycling of phosphorus already present in the lake. In cases where this internal source is large it may result in surface concentrations higher than predicted from landuse loading models and may contribute to water quality violations during the critical summer period. As additional monitoring data become available, these lakes will be assessed for internal contributions and possibly control of these sources by alum or other means. The major sources according to the land use analysis are shown for the lake of interest in the following table (originally part of Table 2 of “Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes” report, 2002).

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Table . Newton Pond MA51110

Total Estimated Nonpoint Source Pollution loads based on GIS Landuse

Watershed Area=	1099.8 Ha (4.2 mi2)
Average Annual Water Load =	6704524.0 m3/yr (7.6 cfs)
Average Runoff=	61.0 cm/yr (24.0 in/yr)
Lake area=	19.4 Ha. (48.0ac)
Areal water loading to lake: q=	34.5 m/yr.
Homes with septic systems within 100m of lake.=	15.0
Other P inputs =	0.0 kg/yr

Estimate of annual Nonpoint Source Pollution Loads by land use

Land use	Area Ha (%)	P Load kg/yr (%)	N Load kg/yr	TSS Load kg/yr
Forest category				
Forest:	675.3 (61.4)	87.8 (26.7)	1688.3	16208.0
Rural category				
Agriculture:	34.6 (3.1)	10.4 (3.2)	304.5	10450.1
Open land:	98.9 (9.0)	29.7 (9.0)	514.3	12227.8
Residential Low:	110.0 (10.0)	33.0 (10.0)	605.1	42688.1
Urban category				
Residential High:	104.7 (9.5)	127.8 (38.9)	811.6	57702.1
Comm - Ind:	26.9 (2.4)	32.8 (10.0)	268.0	10461.7
Other Landuses				
Water:	35.8 (3.3)	0.0 (0.0)	0.0	0.0
Wetlands:	13.5 (1.2)	0.0 (0.0)	0.0	717.9
Subtotal	1099.8	321.5	4228.0	150937.9
Other P inputs:	NA	0.0 (0.0)		
15.0 Septics:	NA	7.5 (2.3)		
Total	1099.8 (100.0)	329.0(100)	4228.0	150937.9

Summary of Lake Total Phosphorus Modeling Results

Areal P loading L= 1.7 g/m2/yr.
Reckhow (1979) model predicts lake TP = L/(11.6+1.2q)*1000 = 31.9 ppb.
Predicted transparency = 1.5 meters.

If all land were forested, P export would be 136.6 kg/yr
and the forested condition lake TP would be 13.3 ppb.

The NPSLAKE model assumes land uses are accurately represented by the MassGIS digital maps and that land use has not changed appreciably since the maps were compiled in 1985. The predicted loading is based on the equation:
P Loading (kg/yr)= 0.5* septics + 0.13* forest ha + 0.3* rural ha + 14* (urban ha)^0.5
The coefficients of the model are based on a combination of values estimated with the aid of multiple regression on a Massachusetts data set and of typical values reported in previous diagnostic/feasibility studies in Massachusetts.
All coefficients fall within the range of values reported in other studies. The overall standard error of the model is approximately 172 kg/yr. If not data is available for internal loading a rough estimate of the magnitude of this sources can be estimated by substitution of the in-lake concentration for TP. The difference in predicted loadings from this approach and the landuse approach is the best estimate of internal loading.

The NPSLAKE model also generates predictions of estimated yearly average water runoff to the lake based on total watershed area and runoff maps of Massachusetts.
Because of the general nature of the landuse loading approach, natural background is included in land use based export coefficients. Natural background can be estimated based on the forest export coefficient of 0.13 kg/ha/yr multiplied by the hectares of the watershed assuming the watershed to be entirely forested. Without site specific information regarding soil phosphorus and natural erosion rates the accuracy of this estimate would be uncertain and would add little value to the analysis.
There were three NPDES point sources listed in the watersheds of some of the lakes, but further investigation revealed they are no longer official point sources, or in one case will no longer be a point source within two months. The one major industrial discharger (Worcester Spinning and Finishing) has since closed after the factory burned down and it is not expected to reopen. A small wastewater point source for Nazzareth Home for Boys is currently being tied into the sewer system of the Leicester Water District with work expected to be completed within two months. The remaining NPDES site was a general permit for Browning Ferris Industries Inc (BFI) which is now covered under an EPA Muti-Sector Permit and is not considered as a point source in this analysis but is included as industrial (urban) landuse in the model.
Reckhow, K.H. 1979. Uncertainty Analysis Applied to Vollenweider's Phosphorus Loading Criteria. J. Water Poll. Control Fed. 51(8):2123-2128
Mattson, M.D. and R.A. Isaac. 1999. Calibration of Phosphorus Export coefficients for Total Maximum Daily Loads of Massachusetts Lakes. Lake and Reservoir Man. 15(3):209-219.
Reckhow, K.H., M.N. Beaulac, J.T. Simpson. 1980. Modeling Phosphorus Loading and Lake Response Under Uncertainty: A Manual and Compilation of Export Coefficients. U.S.E.P.A. Washington DC. EPA 440/5-80-011.

Literature review information:

3. Water Quality Impairments

Known water quality impairments, as documented in the Massachusetts Department of Environmental Protection (MassDEP) 2012 Massachusetts Integrated List of Waters, are listed below. Impairment categories from the Integrated List are as follows:

Table A-2: 2012 MA Integrated List of Waters Categories

Integrated List Category	Description
1	Unimpaired and not threatened for all designated uses.
2	Unimpaired for some uses and not assessed for others.
3	Insufficient information to make assessments for any uses.
4	Impaired or threatened for one or more uses, but not requiring calculation of a Total Maximum Daily Load (TMDL), including: 4a: TMDL is completed 4b: Impairment controlled by alternative pollution control requirements 4c: Impairment not caused by a pollutant - TMDL not required

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5	Impaired or threatened for one or more uses and requiring preparation of a TMDL.

Table A-3: Water Quality Impairments

Assessment Unit ID	Waterbody	Integrated List Category	Designated Use	Impairment Cause	Impairment Source
MA51110	**Newton Pond**	**4A**	Aesthetic	Aquatic Plants (Macrophytes)	Source Unknown
MA51110	**Newton Pond**	**4A**	Fish, other Aquatic Life and Wildlife	Non-Native Aquatic Plants	Introduction of Non-native Organisms (Accidental or Intentional)
MA51110	**Newton Pond**	**4A**	Primary Contact Recreation	Aquatic Plants (Macrophytes)	Source Unknown
MA51110	**Newton Pond**	**4A**	Secondary Contact Recreation	Aquatic Plants (Macrophytes)	Source Unknown

4. Water Quality Goals

Water quality goals may be established for a variety of purposes, including the following:

a.) For **water bodies with known impairments**, a Total Maximum Daily Load (TMDL) is established by MassDEP and the United States Environmental Protection Agency (USEPA) as the maximum amount of the target pollutant that the waterbody can receive and still safely meet water quality standards. If the waterbody has a TMDL for total phosphorus (TP) or total nitrogen (TN), or total suspended solids (TSS), that information is provided below and included as a water quality goal.

b.) For **water bodies without a TMDL for total phosphorus** (TP), a default water quality goal for TP is based on target concentrations established in the Quality Criteria for Water (USEPA, 1986) (also known as the "Gold Book"). The Gold Book states that TP should not exceed 50 ug/L in any stream at the point where it enters any lake or reservoir, nor 25 ug/L within a lake or reservoir. For the purposes of developing WBPs, MassDEP has adopted 50 ug/L as the TP target for all streams at their downstream discharge point, regardless of which type of water body the stream discharges to.

c.) Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013) prescribe the minimum water quality criteria required to sustain a waterbody's designated uses. Newton Pond is a Class 'B' waterbody. The water quality goal for fecal coliform bacteria is based on the Massachusetts Surface Water Quality Standards.

Table A-4: Surface Water Quality Classification by Assessment Unit ID

Assessment Unit ID	Waterbody	Class

MA51110	Newton Pond	B

d.) **Other water quality goals set by the community** (e.g., protection of high quality waters, in-lake phosphorus concentration goal to reduce recurrence of cyanobacteria blooms, etc.).

Table A-5: Water Quality Goals

<table>
<tr><th>Pollutant</th><th>Goal</th><th>Source</th></tr>
<tr><td>Total Phosphorus (TP)</td><td>The following table (originally on page 4 of “Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes” report, 2002) lists the lakes that were evaluated, their predicted total phosphorus concentration and load using the landuse model and selected target concentration and loads necessary to achieve water quality standards. The results indicate that current phosphorus loads to these lakes need to be reduced on an average of 27% and range from a low of about 2% (Eddy Pond, Auburn, MA) to a high of 68% (Southwick Pond, Leicester, MA).
<table>
<tr><th>WBID</th><th>Lake Name</th><th>Predicted TP (ppb)</th><th>Predicted load (kg/yr)</th><th>Tar (pp</th></tr>
<tr><td>MA51004</td><td>Auburn Pond, Auburn</td><td>34</td><td>717</td><td></td></tr>
<tr><td>MA51010</td><td>Brierly Pond, Millbury</td><td>30</td><td>278</td><td></td></tr>
<tr><td>MA51032</td><td>Curtis Pond North, Worcester</td><td>26</td><td>1644</td><td></td></tr>
<tr><td>MA51033</td><td>Curtis Pond South, Worcester</td><td>27</td><td>1609</td><td></td></tr>
<tr><td>MA51039</td><td>Dorothy Pond, Millbury</td><td>26</td><td>366</td><td></td></tr>
<tr><td>MA51043</td><td>Eddy Pond, Auburn</td><td>15</td><td>123</td><td></td></tr>
<tr><td>MA51056</td><td>Green Hill Pond, Worcester</td><td>44.2</td><td>75</td><td></td></tr>
<tr><td>MA51071</td><td>Howe Reservoir, Millbury</td><td>50.9</td><td>104</td><td></td></tr>
<tr><td>MA51078</td><td>Jordan Pond, Shrewsbury</td><td>67.6</td><td>99</td><td></td></tr>
<tr><td>MA51105</td><td>Mill Pond Shrewsbury</td><td>46.5</td><td>275</td><td></td></tr>
<tr><td>MA51110</td><td>Newton Pond Shrewsbury</td><td>31.9</td><td>330</td><td></td></tr>
<tr><td>MA51120</td><td>Pondville Pond, Auburn</td><td>28.1</td><td>453</td><td></td></tr>
<tr><td>MA51156</td><td>Smiths Pond, Leicester</td><td>30</td><td>583</td><td></td></tr>
<tr><td>MA51157</td><td>Southwick Pond, Leicester</td><td>30.4</td><td>108</td><td></td></tr>
<tr><td>MA51160</td><td>Stoneville Pond, Auburn</td><td>26.7</td><td>970</td><td></td></tr>
<tr><td>MA51196</td><td>Shirley Street Pond, Shrewsbury,</td><td>37.7</td><td>670</td><td></td></tr>
</table></td><td>Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes</td></tr>
<tr><td>Bacteria</td><td><u>Class B Standards</u>
• Public Bathing Beaches: For E. coli, geometric mean of 5 most recent samples shall not exceed 126 colonies/ 100 ml and no single sample during the bathing season shall exceed 235 colonies/100 ml. For enterococci, geometric mean of 5 most recent samples shall not exceed 33 colonies/100 ml and no single sample during bathing season shall exceed 61 colonies/100 ml;
• Other Waters and Non-bathing Season at Bathing Beaches: For E. coli, geometric mean of samples from most recent 6 months shall not exceed 126 colonies/100 ml (typically based on min. 5 samples) and no single sample shall exceed 235 colonies/100 ml. For enterococci, geometric mean of samples from most recent 6</td><td>Massachusetts Surface Water Quality Standards (314 CMR 4.00,</td></tr>
</table>

	months shall not exceed 33 colonies/100 ml, and no single sample shall exceed 61 colonies/100 ml.	2013)

Note: *There may be more than one water quality goal for bacteria due to different Massachusetts Surface Water Quality Standards Classes for different Assessment Units within the watershed.*

5. Land Use Information

A. Watershed Land Uses

Table A-6: Watershed Land Uses

Land Use	Area (acres)	% of Watershed
Agriculture	155.1	5.6
Commercial	75.3	2.7
Forest	1746.78	63.5
High Density Residential	73.2	2.7
Highway	5.16	0.2
Industrial	69.55	2.5
Low Density Residential	316.49	11.5
Medium Density Residential	93.02	3.4
Open Land	146.37	5.3
Water	68.66	2.5

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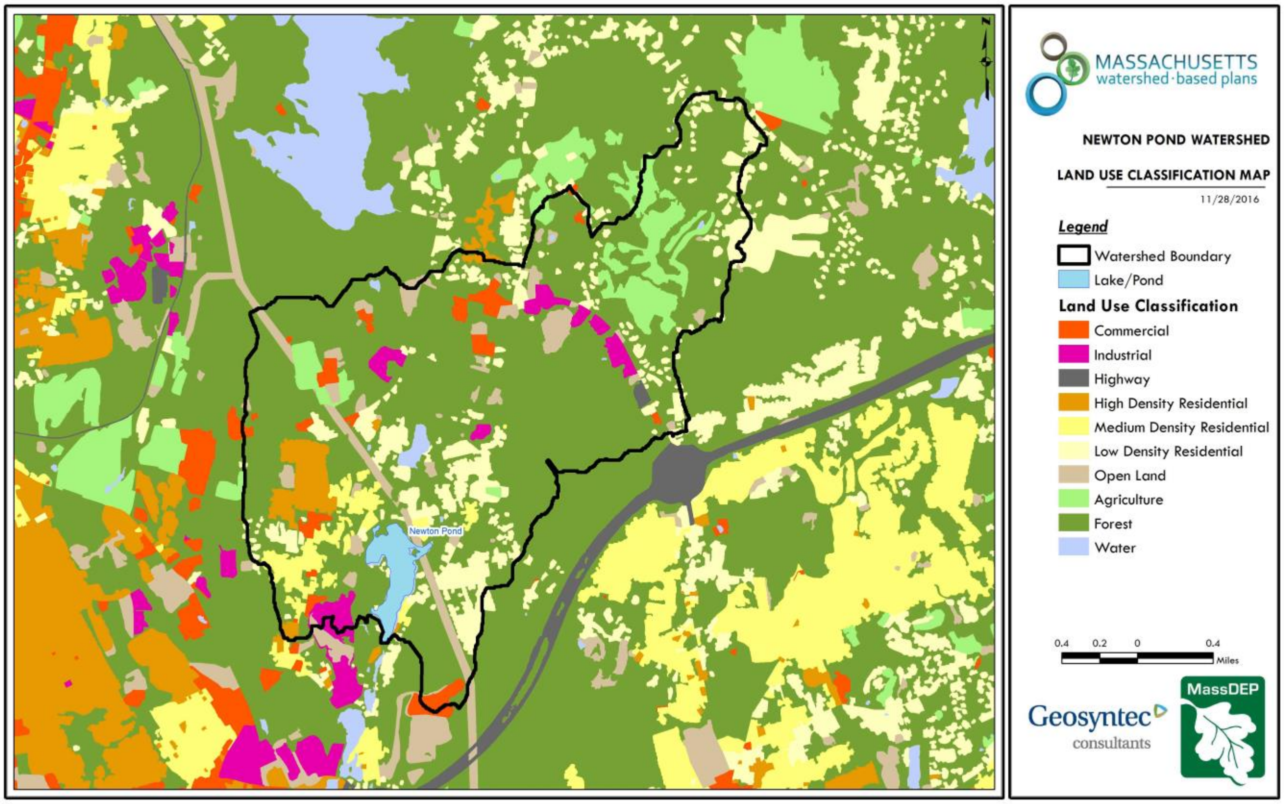

Figure A-2: Watershed Land Use Map (MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Ctrl + Click on the map to view a full sized image in your web browser.

B. Watershed Impervious Cover

There is a strong link between impervious land cover and stream water quality. Impervious cover includes land surfaces that prevent the infiltration of water into the ground, such as paved roads and parking lots, roofs, basketball courts, etc.

Impervious areas that are directly connected (DCIA) to receiving waters (via storm sewers, gutters, or other impervious drainage pathways) produce higher runoff volumes and transport stormwater pollutants with greater efficiency than disconnected impervious cover areas which are surrounded by vegetated, pervious land. Runoff volumes from disconnected impervious cover areas are reduced as stormwater infiltrates when it flows across adjacent pervious surfaces.

An estimate of DCIA for the watershed was calculated based on the Sutherland equations. USEPA provides guidance (USEPA, 2010) on the use of the Sutherland equations to predict relative levels of connection and disconnection based on the type of stormwater infrastructure within the **total impervious area (TIA)** of a watershed. Within each subwatershed, the total area of each land use were summed and used to calculate the percent TIA.

Estimated TIA in the watershed: 12.1 %

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Estimated DCIA in the watershed: 8.9 %

The relationship between TIA and water quality can generally be categorized as follows (Schueler et al. 2009):

Table A-7: Relationship between Total Impervious Area (TIA) and water quality (Schueler et al. 2009)

% Watershed Impervious Cover	Stream Water Quality
0-10%	Typically high quality, and typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects.
11-25%	These streams show clear signs of degradation. Elevated storm flows begin to alter stream geometry, with evident erosion and channel widening. Streams banks become unstable, and physical stream habitat is degraded. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream.
26-60%	These streams typically no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, downcutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Biological quality is typically poor, dominated by pollution tolerant insects and fish. Water quality is consistently rated as fair to poor, and water recreation is often no longer possible due to the presence of high bacteria levels.
>60%	These streams are typical of “urban drainage”, with most ecological functions greatly impaired or absent, and the stream channel primarily functioning as a conveyance for stormwater flows.

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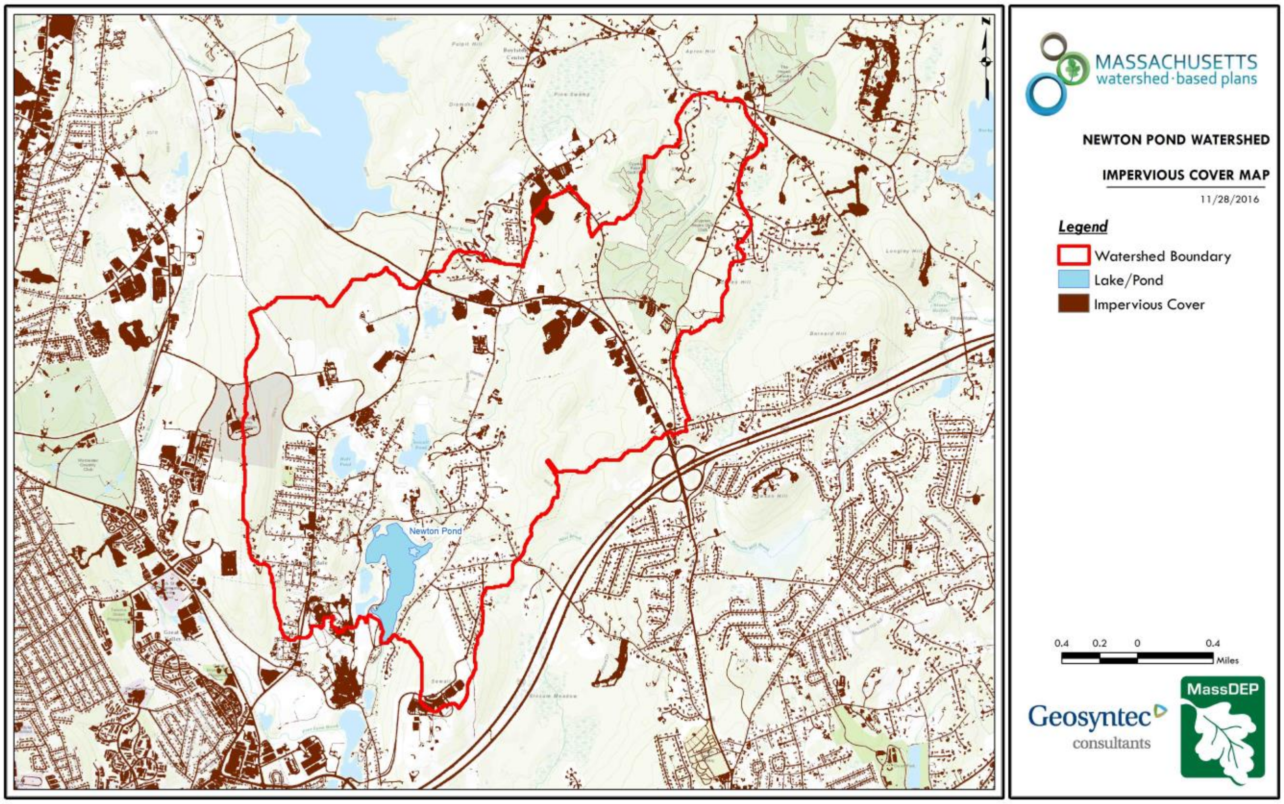

Figure A-3: Watershed Impervious Surface Map (MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Ctrl + Click on the map to view a full sized image in your web browser.

Land use information:

6. Pollutant Loading

The land use data (MassGIS, 2009b) was intersected with impervious cover data (MassGIS, 2009a) and United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soils data (USDA NRCS and MassGIS, 2012) to create a combined land use/land cover grid. The grid was used to sum the total area of each unique land use/land cover type.

The amount of DCIA was estimated using the Sutherland equations as described above and any reduction in impervious area due to disconnection (i.e., the area difference between TIA and DCIA) was assigned to the pervious D soil category for that land use to simulate that some infiltration will likely occur after runoff from disconnected impervious surfaces passes over pervious surfaces.

Pollutant loading for key nonpoint source pollutants in the watershed was estimated by multiplying each land use/cover type area by its pollutant load export rate (PLER). The PLERs are an estimate of the annual total pollutant load exported via stormwater from a given unit area of a particular land cover type. The PLER values for TN, TP and TSS were obtained from USEPA (Voorhees, 2016b) (see documentation provided in Appendix A) as follows:

$$L_n = A_n * P_n$$

Where L_n = Loading of land use/cover type n (lb/yr); A_n = area of land use/cover type n (acres); P_n = pollutant load export rate of land use/cover type n (lb/acre/yr)

Table A-8: Estimated Pollutant Loading for Key Nonpoint Source Pollutants

Land Use Type	Pollutant Loading[1]		
	Total Phosphorus (TP) (lbs/yr)	Total Nitrogen (TN) (lbs/yr)	Total Suspended Solids (TSS) (tons/yr)
Agriculture	90	569	10.05
Commercial	82	709	8.87
Forest	273	1,477	53.37
High Density Residential	49	333	4.94
Highway	5	41	2.59
Industrial	68	587	7.35
Low Density Residential	97	947	13.39
Medium Density Residential	29	236	3.38
Open Land	58	498	11.56
TOTAL	751	5,396	115.49

[1]These estimates do not consider loads from point sources or septic systems.

Pollutant loading information:

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Element B: Determine Pollutant Load Reductions Needed to Achieve Water Quality Goals

Element B of your WBP should:

Determine the pollutant load reductions needed to achieve the water quality goals established in Element A. The water quality goals should incorporate Total Maximum Daily Load (TMDL) goals, when applicable. For impaired water bodies, a TMDL establishes pollutant loading limits as needed to attain water quality standards.

1. Estimated Pollutant Loads

Table 1 lists estimated pollutant loads for the following primary nonpoint source (NPS) pollutants: total phosphorus (TP), total nitrogen (TN), total suspended solids (TSS). These estimated loads are based on the pollutant loading analysis presented in Section 4 of Element A.

2. Water Quality Goals

Water quality goals for primary NPS pollutants are listed in Table 1 based on the following:

- TMDL water quality goals (if a TMDL exists for the water body);
- For all water bodies, including impaired waters that have a pathogen TMDL, the water quality goal for bacteria is based on the Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013) that apply to the Water Class of the selected water body.
- If the water body does not have a TMDL for TP, a default target TP concentrations is provided which is based on guidance provided by the USEPA in Quality Criteria for Water (1986), also known as the "Gold Book". Because there are no similar default water quality goals for TN and TSS, goals for these pollutants are provided in Table 1 only if a TMDL exists or alternate goal(s) have been optionally established by the WBP author.
- According to the USEPA Gold Book, total phosphorus should not exceed 50 ug/L in any stream at the point where it enters any lake or reservoir. The water quality loading goal was estimated by multiplying this target maximum phosphorus concentration (50 ug/L) by the estimated annual watershed discharge for the selected water body. To estimate the annual watershed discharge, the mean flow was used, which was estimated based on United States Geological Survey (USGS) "Runoff Depth" estimates for Massachusetts (Cohen and Randall, 1998). Cohen and Randall (1998) provide statewide estimates of annual Precipitation (P), Evapotranspiration (ET), and Runoff (R) depths for the northeastern U.S. According to their method, Runoff Depth (R) is defined as all water reaching a discharge point (including surface and groundwater), and is calculated by:

$$P - ET = R$$

A mean Runoff Depth R was determined for the watershed by calculating the average value of R within the watershed boundary. This method includes the following assumptions/limitations:

a. For lakes and ponds, the estimate of annual TP loading is averaged across the entire watershed. However, a given lake or reservoir may have multiple tributary streams, and each stream may drain land with vastly different characteristics. For example, one tributary may drain a highly developed residential area, while a second tributary may drain primarily forested and undeveloped land. In this case, one tributary may exhibit much higher phosphorus concentrations than the average of all streams in the selected watershed.

b. The estimated existing loading value only accounts for phosphorus due to stormwater runoff. Other sources of phosphorus may be relevant, particularly phosphorus from on-site wastewater treatment (septic systems) within close proximity to receiving waters. Phosphorus does not typically travel far within an aquifer, but in watersheds that are primarily unsewered, septic systems and other similar groundwater-related sources may contribute a significant load of phosphorus that is not captured in this analysis. As such, it is important to consider the estimated TP loading as "the expected TP loading from stormwater sources."

Table B-1: Pollutant Load Reductions Needed

Pollutant	Existing Estimated Total Load	Water Quality Goal	Required Load Reduction
Total Phosphorus	See TMDL information below	See TMDL information below	See TMDL information below
Total Nitrogen	5396 lbs/yr		
Total Suspended Solids	115 ton/yr		
Bacteria	*MSWQS for bacteria are concentration standards (e.g., colonies of fecal coliform bacteria per 100 ml), which are difficult to predict based on estimated annual loading.*	Class B. **Class B Standards** • Public Bathing Beaches: For E. coli, geometric mean of 5 most recent samples shall not exceed 126 colonies/ 100 ml and no single sample during the bathing season shall exceed 235 colonies/100 ml. For enterococci, geometric mean of 5 most recent samples shall not exceed 33 colonies/100 ml and no single sample during bathing season shall exceed 61 colonies/100 ml; • Other Waters and Non-bathing Season at Bathing Beaches: For E. coli, geometric mean of samples from most recent 6 months shall not exceed 126 colonies/100 ml (typically based on min. 5 samples) and no single sample shall exceed 235 colonies/100 ml. For	

		enterococci, geometric mean of samples from most recent 6 months shall not exceed 33 colonies/100 ml, and no single sample shall exceed 61 colonies/100 ml.	

TMDL Pollutant Load Criteria

Total Phosphorus (MA51110)

Loading Capacity
Modeling Assumptions, Key Input, Calibration and Validation:
There are no numeric models available to predict the growth of rooted aquatic macrophytes as a function of nutrient loading estimates, therefore the control of nuisance aquatic plants is based on best professional judgment. However, the goal of the TMDL is to prevent future eutrophication from occurring, thus the nutrient loading still needs to be controlled. To control eutrophication, the Carlson Trophic State Index (TSI) predicts a lake should have total phosphorus concentrations of about 40 ppb to meet the 4-foot transparency requirement for swimming beaches in Massachusetts and targets are set lower than this. Due to the lack of data on mean depth and other parameters, a simple water quality model was used to link watershed phosphorus loading to in-lake total phosphorus concentration targets. Based on the NPSLAKE model phosphorus loading output and predicted water runoff volumes, an estimated in-lake total phosphorus (TP) concentration was derived based on the Reckhow (1979) model:
TP=L/(11.6+1.2*q)*1000
where
TP= the predicted average total phosphorus concentration (mg/l) in the lake.
L= Phosphorus loading in g/m2/yr (the total loading in grams divided by lake area in meters).
q= The areal water loading in m/yr from total water runoff in m3/yr divided by lake area in m2.
Similarly, by setting the TP to the target total phosphorus concentration, a target load was estimated by solving the equation above. As noted in Mattson and Isaac (1999) the Reckhow (1979) model was developed on similar, north temperate lakes and most Massachusetts lakes will fall within the range of phosphorus loading and hydrology of the calibration data set. Additional assumptions, and details of calibration and validation are given in Reckhow (1979).
Wasteload Allocations, Load Allocations and Margin of Safety:
For most lakes, point source wasteload allocation is zero. The margin of safety is set by establishing a target that is below that expected to meet the 4-foot swimming standard (about 40 ppb). Thus, the TMDL is the same as the target load allocation to nonpoint sources as indicated in the right side of the following table (originally part of Table 4 of "Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes" report, 2002). Loading allocations are based on the NPSLAKE landuse modeled phosphorus budget. Note that if lakes have surface TP concentrations that are much larger than that predicted by the NPSLAKE model, internal sources of phosphorus, such as the sediments, may also be a contributing source of phosphorus to the surface waters and should be considered for further evaluation and control.

Table . Newton Pond MA51110 TMDL Load Allocation.

Source	*Current TP Loading (kg/yr)*	*Target TP Load Allocation (kg/yr)*
Forest	88	88
Agriculture	10	7
Open Land	30	21
Residential (Low den.)	33	23
Residential (High den.)	128	90
Comm. Indust.	33	23
Septic System	8	5
Other	0	0
Total Inputs	330	257

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Phosphorus loading allocations for each landuse category are shown (are rounded to the nearest kg/yr) in the above table. No reduction in forest loading is targeted, because other than logging operations, which are relatively rare and already have BMPs in place, this source is unlikely to be reduced by additional BMPs. The remaining load reductions are allocated as a proportional phosphorus loading reduction.
The TMDL is the sum of the wasteload allocations (WLA) from point sources (e.g., sewage treatment plants) plus load allocations (LA) from nonpoint sources (e.g., landuse sources) plus a margin of safety (MOS). Thus, the TMDL can be written as:
TMDL = WLA + LA + MOS
Seasonality:
As the term implies, TMDLs are often expressed as maximum daily loads. However, as specified in 40 CFR 130.2(I), TMDLs may be expressed in other terms when appropriate. For this case, the TMDL is expressed in terms of allowable annual loadings of phosphorus. Although critical conditions occur during the summer season when weed growth is more likely to interfere with uses, water quality in many lakes is generally not sensitive to daily or short term loading, but is more a function of loadings that occur over longer periods of time (e.g. annually).
Therefore, seasonal variation is taken into account with the estimation of annual loads. In addition, evaluating the effectiveness of nonpoint source controls can be more easily accomplished on an annual basis rather than a daily basis.
For most lakes, it is appropriate and justifiable to express a nutrient TMDL in terms of allowable annual loadings. The annual load should inherently account for seasonal variations by being protective of the most sensitive time of year. The most sensitive time of year in most lakes occurs during summer, when the frequency and occurrence of nuisance algal blooms and macrophyte growth are usually greatest. Therefore, because these phosphorus TMDLs were established to be protective of the most environmentally sensitive period (i.e., the summer season), it will also be protective of water quality during all other seasons. Additionally, the targeted reduction in annual phosphorus load to the ponds will result in the application of phosphorus controls that also address seasonal variation. For example, certain control practices such as stabilizing eroding drainage ways or maintaining septic systems will be in place throughout the year while others will be in effect during the times the sources are active (e.g., application of lawn fertilizer).
Reckhow, K.H. 1979. Uncertainty Analysis Applied to Vollenweider's Phosphorus Loading Criteria. J. Water Poll. Control Fed. 51(8):2123-2128
Mattson, M.D. and R.A. Isaac. 1999. Calibration of Phosphorus Export coefficients for Total Maximum Daily Loads of Massachusetts Lakes. Lake and Reservoir Man. 15(3):209-219.

Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes

Pollutant load reduction information:

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Element C: Describe management measures that will be implemented to achieve water quality goals

Element C: A description of the nonpoint source management measures needed to achieve the pollutant load reductions presented in Element B, and a description of the critical areas where those measures will be needed to implement this plan.

Table C1 presents the proposed management measures as well as the estimated pollutant load reductions and costs. The planning level cost estimates and pollutant load reduction estimates and estimates of BMP footprint were based off information obtained in the following sources and were also adjusted to 2016 values using the Consumer Price Index (CPI) (United States Bureau of Labor Statistics, 2016):

- Geosyntec Consultants, Inc. (2014);
- Geosyntec Consultants, Inc. (2015);
- King and Hagen (2011);
- Leisenring, et al. (2014);
- King and Hagen (2011);
- MassDEP (2016a);
- MassDEP (2016b);
- University of Massachusetts, Amherst (2004);
- Voorhees (2015);
- Voorhees (2016a);
- Voorhees (2016b);

Table C-1: Proposed Management Measures, Estimated Pollutant Load Reductions and Costs

Structural BMPs
No Structural BMP Data Found

Additional BMPs
No Additional BMP Data Found

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Element D: Identify Technical and Financial Assistance Needed to Implement Plan

Element D: Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

Table D-1 presents the funding needed to implement the management measures presented in this watershed plan. The table includes costs for structural and non-structural BMPs, operation and maintenance activities, information/education measures, and monitoring/evaluation activities.

Table D-1: Summary of Funding Needed to Implement the Watershed Plan.

Management Measures	Location	Capital Costs	Operation & Maintenance Costs	Relevant Authorities	Technical Assistance Needed	Funding Needed
Structural and Non-Structural BMPs (from Element C)						
Information/Education (see Element E)						
Monitoring and Evaluation (see Element H/I)						
					Total Funding Needed:	
Funding Sources:						

Element E: Public Information and Education

Element E: Information and Education (I/E) component of the watershed plan used to:

1. Enhance public understanding of the project; and
2. Encourage early and continued public participation in selecting, designing, and implementing the NPS management measures that will be implemented.

Step 1: Goals and Objectives

The goals and objectives for the watershed information and education program.

Step 2: Target Audience

Target audiences that need to be reached to meet the goals and objectives identified above.

Step 3: Outreach Products and Distribution

The outreach product(s) and distribution form(s) that will be used for each.

Step 4: Evaluate Information/Education Program

Information and education efforts and how they will be evaluated.

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Other Information

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Elements F & G: Implementation Schedule and Measurable Milestones

Element F: Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

Element G: A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

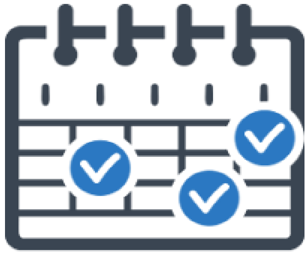

Table FG-1: Implementation Schedule and Interim Measurable Milestones

A. Structural & Non-Structural BMPs
No Data Found

B. Public Education & Outreach
No Data Found

C. Monitoring
No Data Found

Scheduling and milestone information:

Elements H & I: Progress Evaluation Criteria and Monitoring

Element H: A set of criteria used to determine (1) if loading reductions are being achieved over time and (2) if progress is being made toward attaining water quality goals. Element H asks "**how will you know if you are making progress towards water quality goals?**" The criteria established to track progress can be direct measurements (e.g., E. coli bacteria concentrations) or indirect indicators of load reduction (e.g., number of beach closings related to bacteria).

Element I: A monitoring component to evaluate the effectiveness of implementation efforts over time, as measured against the Element H criteria. Element I asks "**how, when, and where will you conduct monitoring?**"

The water quality target concentration(s) is presented under Element A of this plan. To achieve this target concentration, the annual loading must be reduced to the amount described in Element B. Element C of this plan describes the various management measures that will be implemented to achieve this targeted load reduction. The evaluation criteria and monitoring program described below will be used to measure the effectiveness of the proposed management measures (described in Element C) in improving the water quality of Gulf Pond.

Indirect Indicators of Load Reduction

Project-Specific Indicators

TMDL Criteria

Direct Measurements

Adaptive Management

References / Appendix

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Water Quality Assessment Reports

"*Blackstone River Watershed 2003-2007 Water Quality Assessment Report*"

TMDL

"*Total Maximum Daily Loads of Phosphorus for Selected Northern Blackstone Lakes*"

Appendix A – Pollutant Load Export Rates (PLERs)

Land Use & Cover[1]	PLERs (lb/acre/year)		
	(TP)	(TSS)	(TN)
AGRICULTURE, HSG A	0.45	7.14	2.59
AGRICULTURE, HSG B	0.45	29.4	2.59
AGRICULTURE, HSG C	0.45	59.8	2.59
AGRICULTURE, HSG D	0.45	91.0	2.59
AGRICULTURE, IMPERVIOUS	1.52	650	11.3
COMMERCIAL, HSG A	0.03	7.14	0.27
COMMERCIAL, HSG B	0.12	29.4	1.16
COMMERCIAL, HSG C	0.21	59.8	2.41
COMMERCIAL, HSG D	0.37	91.0	3.66
COMMERCIAL, IMPERVIOUS	1.78	377	15.1
FOREST, HSG A	0.12	7.14	0.54
FOREST, HSG B	0.12	29.4	0.54
FOREST, HSG C	0.12	59.8	0.54
FOREST, HSG D	0.12	91.0	0.54
FOREST, HSG IMPERVIOUS	1.52	650	11.3
HIGH DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
HIGH DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
HIGH DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
HIGH DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
HIGH DENSITY RESIDENTIAL, IMPERVIOUS	2.32	439	14.1
HIGHWAY, HSG A	0.03	7.14	0.27
HIGHWAY, HSG B	0.12	29.4	1.16
HIGHWAY, HSG C	0.21	59.8	2.41
HIGHWAY, HSG D	0.37	91.0	3.66
HIGHWAY, IMPERVIOUS	1.34	1,480	10.2
INDUSTRIAL, HSG A	0.03	7.14	0.27
INDUSTRIAL, HSG B	0.12	29.4	1.16

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INDUSTRIAL, HSG C	0.21	59.8	2.41
INDUSTRIAL, HSG D	0.37	91.0	3.66
INDUSTRIAL, IMPERVIOUS	1.78	377	15.1
LOW DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
LOW DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
LOW DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
LOW DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
LOW DENSITY RESIDENTIAL, IMPERVIOUS	1.52	439	14.1
MEDIUM DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
MEDIUM DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
MEDIUM DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
MEDIUM DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
MEDIUM DENSITY RESIDENTIAL, IMPERVIOUS	1.96	439	14.1
OPEN LAND, HSG A	0.12	7.14	0.27
OPEN LAND, HSG B	0.12	29.4	1.16
OPEN LAND, HSG C	0.12	59.8	2.41
OPEN LAND, HSG D	0.12	91.0	3.66
OPEN LAND, IMPERVIOUS	1.52	650	11.3
[1]HSG = Hydrologic Soil Group			

Massachusetts Year 2014 Integrated List of Waters

Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act

Massachusetts Department of Environmental Protection

CN 450.1

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Matthew A. Beaton, Secretary
Massachusetts Department of Environmental Protection
Martin Suuberg, Commissioner
Bureau of Water Resources
Douglas E. Fine, Assistant Commissioner

Massachusetts Category 4a Waters
"TMDL is completed"

NAME	SEGMENT ID	DESCRIPTION	SIZE	UNITS	POLLUTANTS ADDRESSED BY TMDL	EPA TMDL NUMBER
Blackstone						
Brierly Pond	MA51010	Millbury	18	ACRES	(Non-Native Aquatic Plants*)	
					Aquatic Plants (Macrophytes)	175
Dorothy Pond	MA51039	Millbury	133	ACRES	(Eurasian Water Milfoil, Myriophyllum spicatum*)	
					(Non-Native Aquatic Plants*)	
					Turbidity	379
Eddy Pond	MA51043	Auburn	99	ACRES	(Non-Native Aquatic Plants*)	
					Aquatic Plants (Macrophytes)	2382
Flint Pond	MA51050	[North Basin] Shrewsbury	92	ACRES	(Eurasian Water Milfoil, Myriophyllum spicatum*)	
					(Non-Native Aquatic Plants*)	
					Aquatic Plants (Macrophytes)	444
					Turbidity	444
Flint Pond	MA51188	[South Basin] Shrewsbury/Grafton/Worcester	173	ACRES	(Eurasian Water Milfoil, Myriophyllum spicatum*)	
					(Non-Native Aquatic Plants*)	
					Aquatic Plants (Macrophytes)	444
Green Hill Pond	MA51056	Worcester	29	ACRES	Turbidity	498
Howe Reservoirs	MA51071	[West Basin] Millbury	7	ACRES	Aquatic Plants (Macrophytes)	550
Indian Lake	MA51073	Worcester	186	ACRES	(Eurasian Water Milfoil, Myriophyllum spicatum*)	
					Aquatic Plants (Macrophytes)	2323
					Oxygen, Dissolved	2323
Jordan Pond	MA51078	Shrewsbury	18	ACRES	Turbidity	2385
Lake Quinsigamond	MA51125	Shrewsbury/Worcester	471	ACRES	(Eurasian Water Milfoil, Myriophyllum spicatum*)	
					(Non-Native Aquatic Plants*)	
					Excess Algal Growth	644
					Oxygen, Dissolved	644
Leesville Pond	MA51087	Auburn/Worcester	34	ACRES	(Non-Native Aquatic Plants*)	
					Oxygen, Dissolved	671
					Phosphorus (Total)	671
Mill Pond	MA51105	Shrewsbury	12	ACRES	Turbidity	804
Newton Pond	MA51110	Shrewsbury/Boylston	54	ACRES	(Non-Native Aquatic Plants*)	
					Aquatic Plants (Macrophytes)	862

* TMDL not required (Non-pollutant)

Massachusetts Year 2016 Integrated List of Waters

Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act

CN 470.1

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Kathleen A. Theoharides, Secretary
Massachusetts Department of Environmental Protection
Martin Suuberg, Commissioner
Bureau of Water Resources
Kathleen Baskin, Assistant Commissioner

Category 4c waters listed alphabetically by major watershed
"Impairment not caused by a pollutant – TMDL not required"

Water Body	Segment ID	Description	Size	Units	Impairment
Blackstone					
Brierly Pond	MA51010	Millbury.	18.00	Acres	(Aquatic Plants (Macrophytes)*)
					(Non-Native Aquatic Plants*)
Coes Reservoir	MA51024	Worcester.	87.00	Acres	(Eurasian Water Milfoil, Myriophyllum spicatum*)
Dark Brook Reservoir	MA51035	[South Basin] Auburn.	58.00	Acres	(Eurasian Water Milfoil, Myriophyllum spicatum*)
					(Non-Native Aquatic Plants*)
Dark Brook Reservoir	MA51036	[North Basin] Auburn.	171.00	Acres	(Eurasian Water Milfoil, Myriophyllum spicatum*)
Girard Pond	MA51053	Sutton.	2.00	Acres	(Non-Native Aquatic Plants*)
Howe Reservoirs	MA51070	[East Basin] Millbury.	2.00	Acres	(Dewatering*)
					(Non-Native Aquatic Plants*)
Ironstone Reservoir	MA51074	Uxbridge.	28.00	Acres	(Non-Native Aquatic Plants*)
Jenks Reservoir	MA51075	Bellingham.	26.00	Acres	(Non-Native Aquatic Plants*)
Mill Pond	MA51104	Upton.	10.00	Acres	(Non-Native Aquatic Plants*)
Miscoe Lake	MA51106	Wrentham (size indicates portion in Massachusetts) (entire portion in MA is from 1000 feet upstream of the state line, these interstate surface waters are public water supply in Rhode Island and designated in MA as Class A/PWS/ORW).	5.00	Acres	(Non-Native Aquatic Plants*)
Newton Pond	MA51110	Shrewsbury/Boylston.	54.00	Acres	(Non-Native Aquatic Plants*)
North Pond	MA51112	Hopkinton/Milford.	231.00	Acres	(Non-Native Aquatic Plants*)
Pratt Pond	MA51123	Upton.	40.00	Acres	(Non-Native Aquatic Plants*)
Quinsigamond River	MA51-09	Headwaters, outlet Flint Pond, Grafton to confluence with the Blackstone River in Fisherville Pond, Grafton (excluding approximately 0.5 mile through Lake Ripple segment MA51135) (segment includes all of Hovey Pond formerly segment MA51068 and a portion of Fisherville Pond formerly segment MA51048).	5.20	Miles	(Eurasian Water Milfoil, Myriophyllum spicatum*)
					(Non-Native Aquatic Plants*)
Riverlin Street Pond	MA51137	Millbury.	2.00	Acres	(Non-Native Aquatic Plants*)
Rivulet Pond	MA51138	Uxbridge.	4.00	Acres	(Non-Native Aquatic Plants*)
Sibley Reservoir	MA51148	Sutton.	25.00	Acres	(Dewatering*)
Silver Lake	MA51150	Bellingham.	42.00	Acres	(Non-Native Aquatic Plants*)
Silver Lake	MA51151	Grafton.	25.00	Acres	(Dewatering*)
Singletary Pond	MA51152	Sutton/Millbury.	341.00	Acres	(Eurasian Water Milfoil, Myriophyllum spicatum*)
					(Non-Native Aquatic Plants*)
Stevens Pond	MA51159	Sutton.	85.00	Acres	(Non-Native Aquatic Plants*)
Swans Pond	MA51164	Sutton/Northbridge.	32.00	Acres	(Non-Native Aquatic Plants*)
Taft Pond	MA51165	Upton.	11.00	Acres	(Non-Native Aquatic Plants*)

Appendix 3
Impairments *removed* from categories 4 or 5 of the integrated list in 2016
(waters listed alphabetically by major watershed)

		Category				
Water Body	**Segment ID**	**2014**	**2016**	**Impairment Cause**	**EPA TMDL No.**	**Explanation**
Blackstone						
Beaver Brook	MA51-07	5	5	(Debris/Floatables/Trash*)		Applicable WQS attained; reason for recovery unspecified.
				Taste and Odor		Applicable WQS attained; reason for recovery unspecified.
Blackstone River	MA51-04	5	5	DDT (dichlorodiphenyltrichloroethane)		Impairment changed from "DDT" to "DDT in Fish Tissue".
Blackstone River	MA51-06	5	5	DDT (dichlorodiphenyltrichloroethane)		Impairment changed from "DDT" to "DDT in Fish Tissue".
Brierly Pond	MA51010	4A	4C	Aquatic Plants (Macrophytes)	175	Not caused by a pollutant, impairment still exists.
Dark Brook	MA51-16	5	5	Aquatic Plants (Macrophytes)	2377	Applicable WQS attained; reason for recovery unspecified.
Eddy Pond	MA51043	4A	4A	Aquatic Plants (Macrophytes)	2382	Not caused by a pollutant, impairment still exists.
				Nutrient/Eutrophication Biological Indicators	2382	New impairment, covered under existing TMDL [CN 070.1, 5/2/2002], added to this segment for 2016.
Flint Pond	MA51050	4A	4A	Aquatic Plants (Macrophytes)	444	Not caused by a pollutant, impairment still exists.
				Nutrient/Eutrophication Biological Indicators	444	New impairment, covered under existing TMDL [CN 115.0, 6/28/2002], added to this segment for 2016.
Flint Pond	MA51188	4A	4A	Aquatic Plants (Macrophytes)	444	Not caused by a pollutant, impairment still exists.
				Nutrient/Eutrophication Biological Indicators	444	New impairment, covered under existing TMDL [CN 115.0, 6/28/2002], added to this segment for 2016.
Howe Reservoirs	MA51071	4A	4A	Aquatic Plants (Macrophytes)	550	Not caused by a pollutant, impairment still exists.
				Nutrient/Eutrophication Biological Indicators	550	New impairment, covered under existing TMDL [CN 070.1, 5/2/2002], added to this segment for 2016.
Indian Lake	MA51073	4A	4A	Aquatic Plants (Macrophytes)	2323	Applicable WQS attained; according to new assessment method.
				Harmful Algal Blooms	2323	New impairment, covered under existing TMDL [CN 116.0, 6/28/2002], added to this segment for 2016.
				Nutrient/Eutrophication Biological Indicators	2323	New impairment, covered under existing TMDL [CN 116.0, 6/28/2002], added to this segment for 2016.
Jordan Pond	MA51078	4A	4A	Harmful Algal Blooms	2385	New impairment, covered under existing TMDL [CN 070.1, 5/2/2002], added to this segment for 2016.
Kettle Brook	MA51-01	5	5	(Debris/Floatables/Trash*)		Applicable WQS attained; reason for recovery unspecified.
				Aquatic Plants (Macrophytes)	2391	Applicable WQS attained; reason for recovery unspecified.
				Turbidity	2389	Applicable WQS attained; reason for recovery unspecified.
Mill River	MA51-36	5	5	Aquatic Plants (Macrophytes)		Applicable WQS attained; according to new assessment method.
Newton Pond	MA51110	4A	4C	Aquatic Plants (Macrophytes)	862	Applicable WQS attained; according to new assessment method.
Shirley Street Pond	MA51196	4A	4A	Aquatic Plants (Macrophytes)	2392	Not caused by a pollutant, impairment still exists.
				Nutrient/Eutrophication Biological Indicators	2392	New impairment, covered under existing TMDL [CN 070.1, 5/2/2002], added to this segment for 2016.
Singletary Brook	MA51-31	5	5	Aquatic Plants (Macrophytes)		Original basis for listing was incorrect.

* TMDL not required (Non-pollutant)